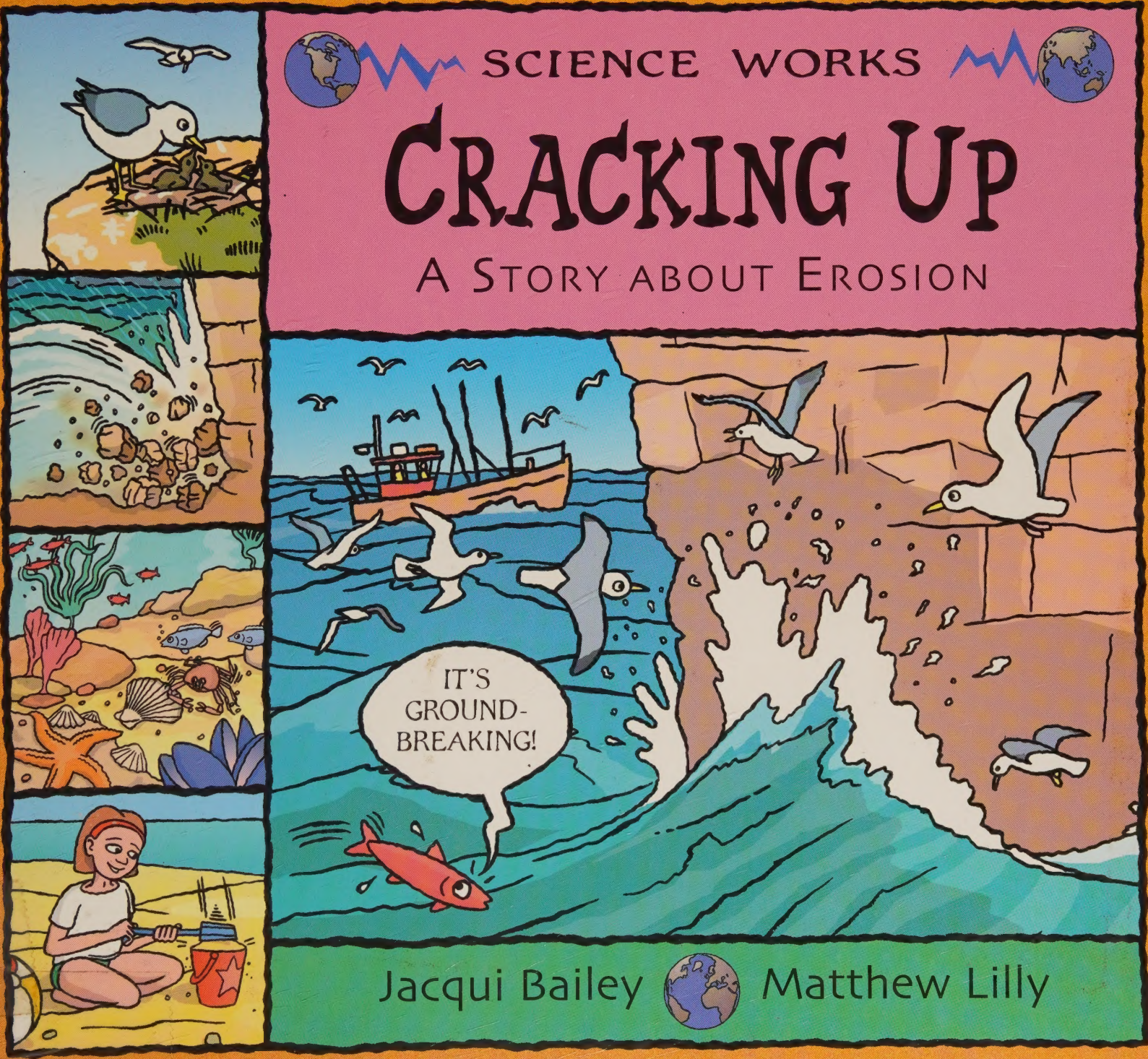
SCIENCE WORKS

CRACKING UP

A STORY ABOUT EROSION



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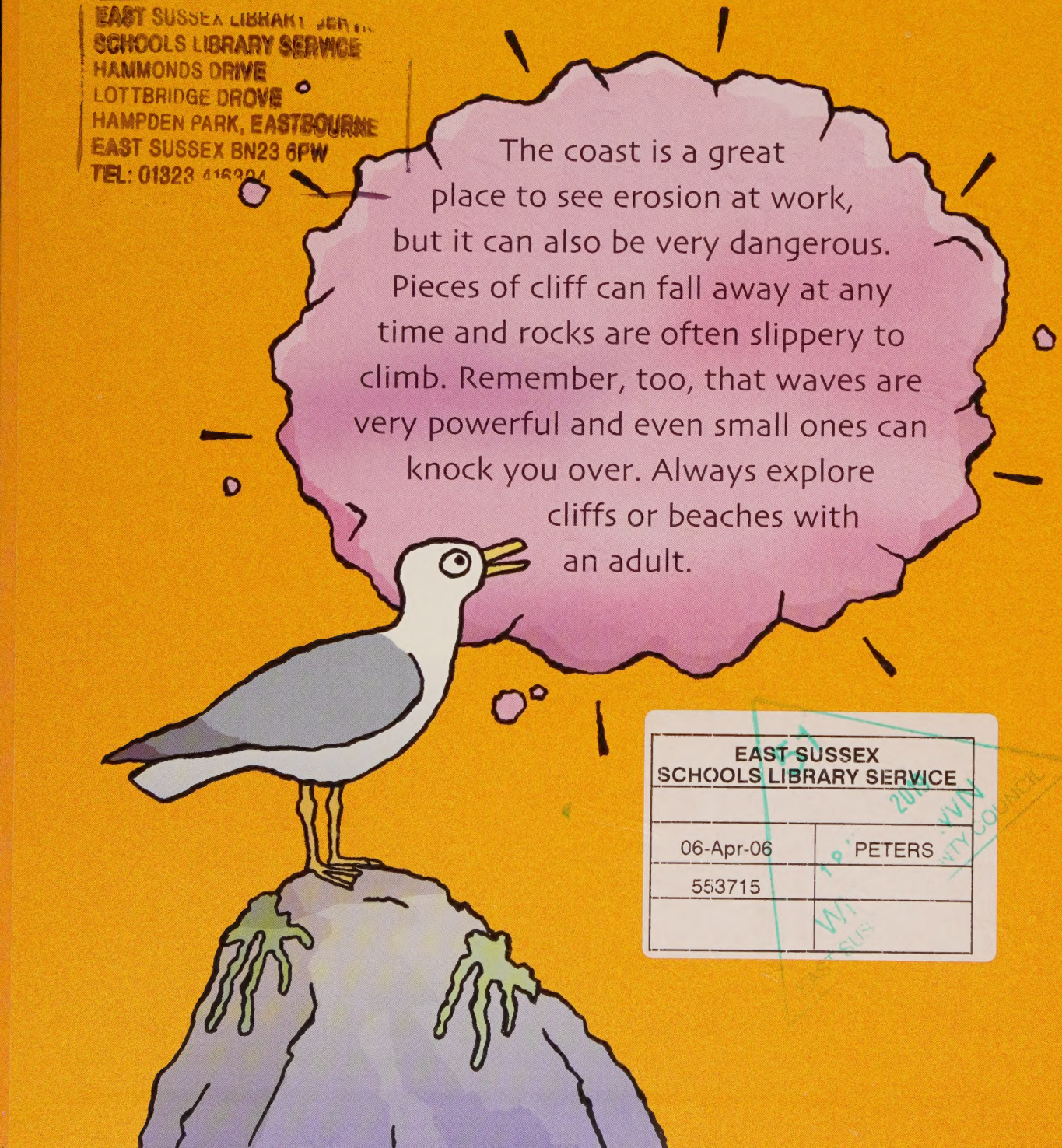
The coast is a great place to see erosion at work, but it can also be very dangerous. Pieces of cliff can fall away at any time and rocks are often slippery to climb. Remember, too, that waves are very powerful and even small ones can knock you over. Always explore cliffs or beaches with an adult.

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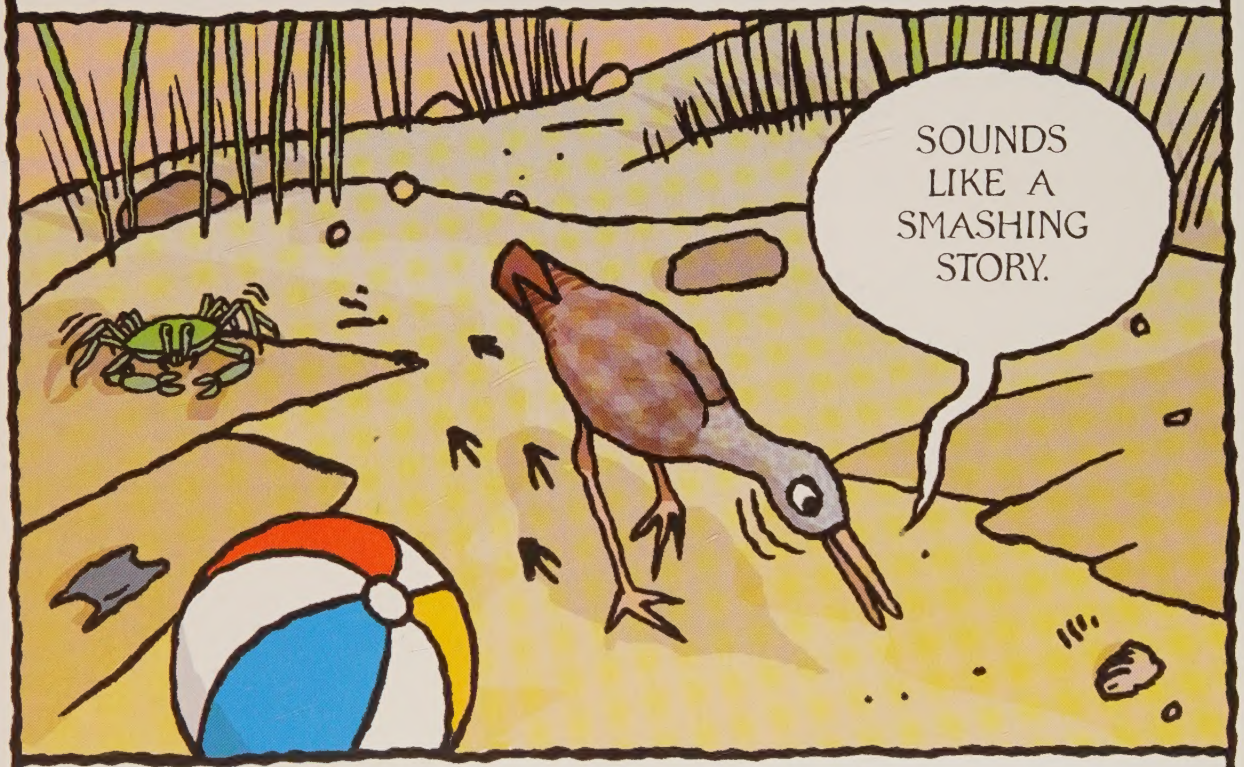
SCIENCE WORKS

CRACKING UP

A STORY ABOUT EROSION



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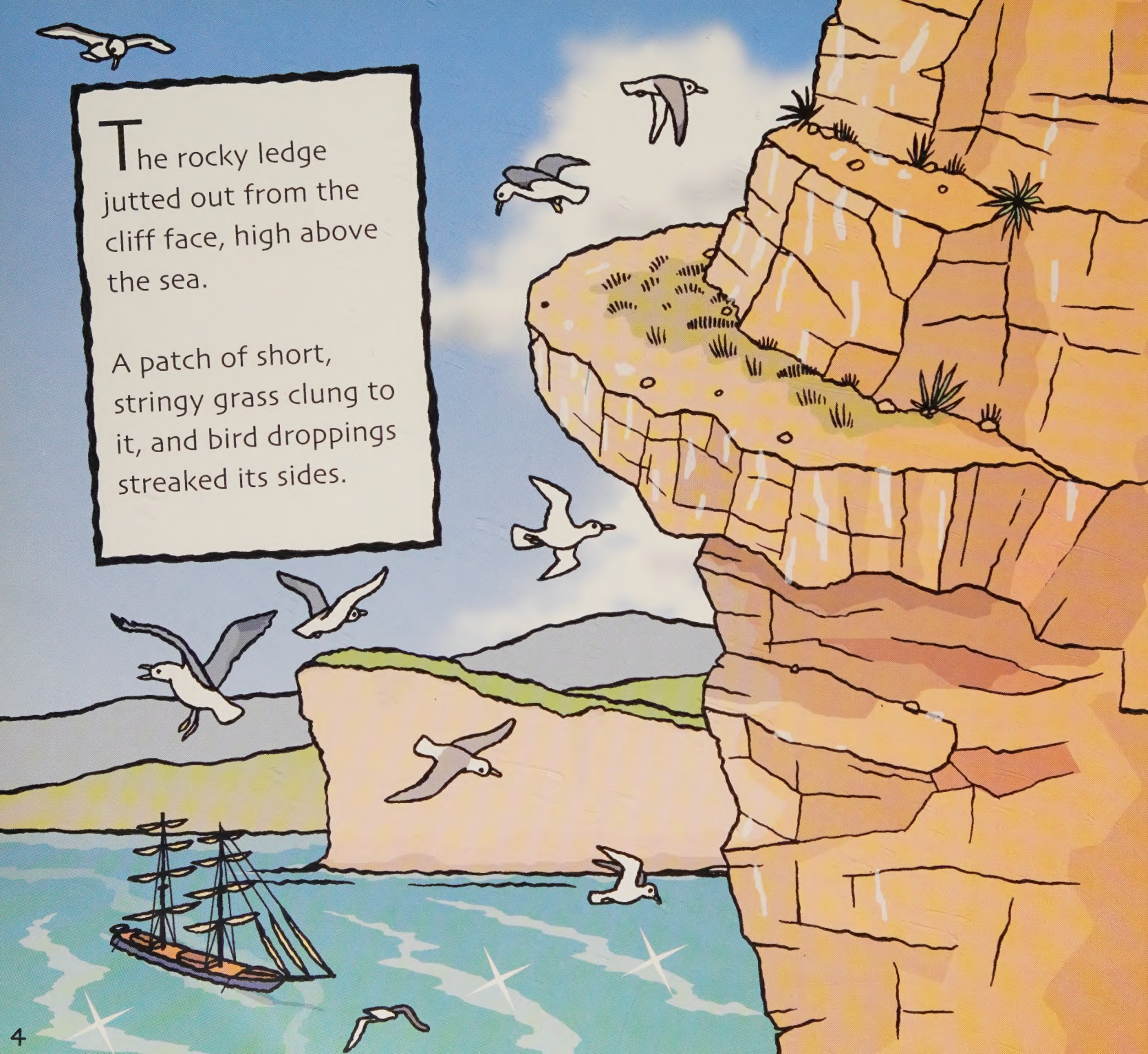
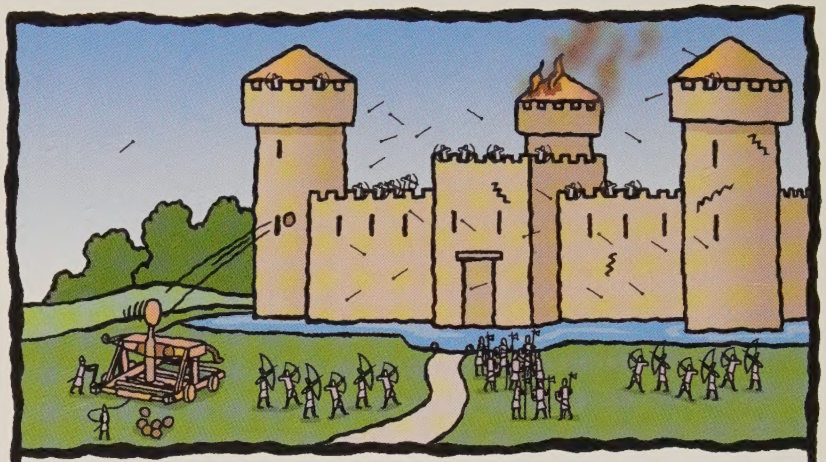
A & C BLACK • LONDON


The rocky ledge jutted out from the cliff face, high above the sea.

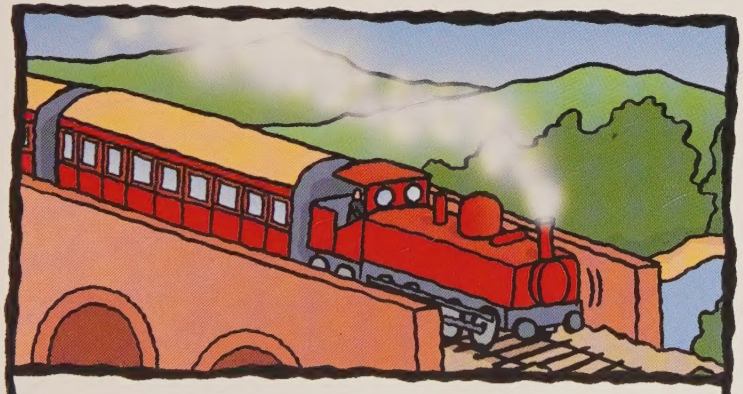
A patch of short, stringy grass clung to it, and bird droppings streaked its sides.

The ledge had been there for a very long time.

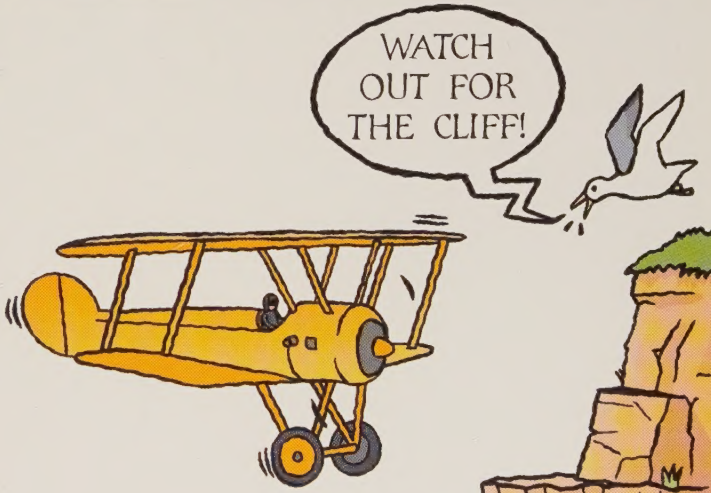
It was there when the Roman Empire came, and went.



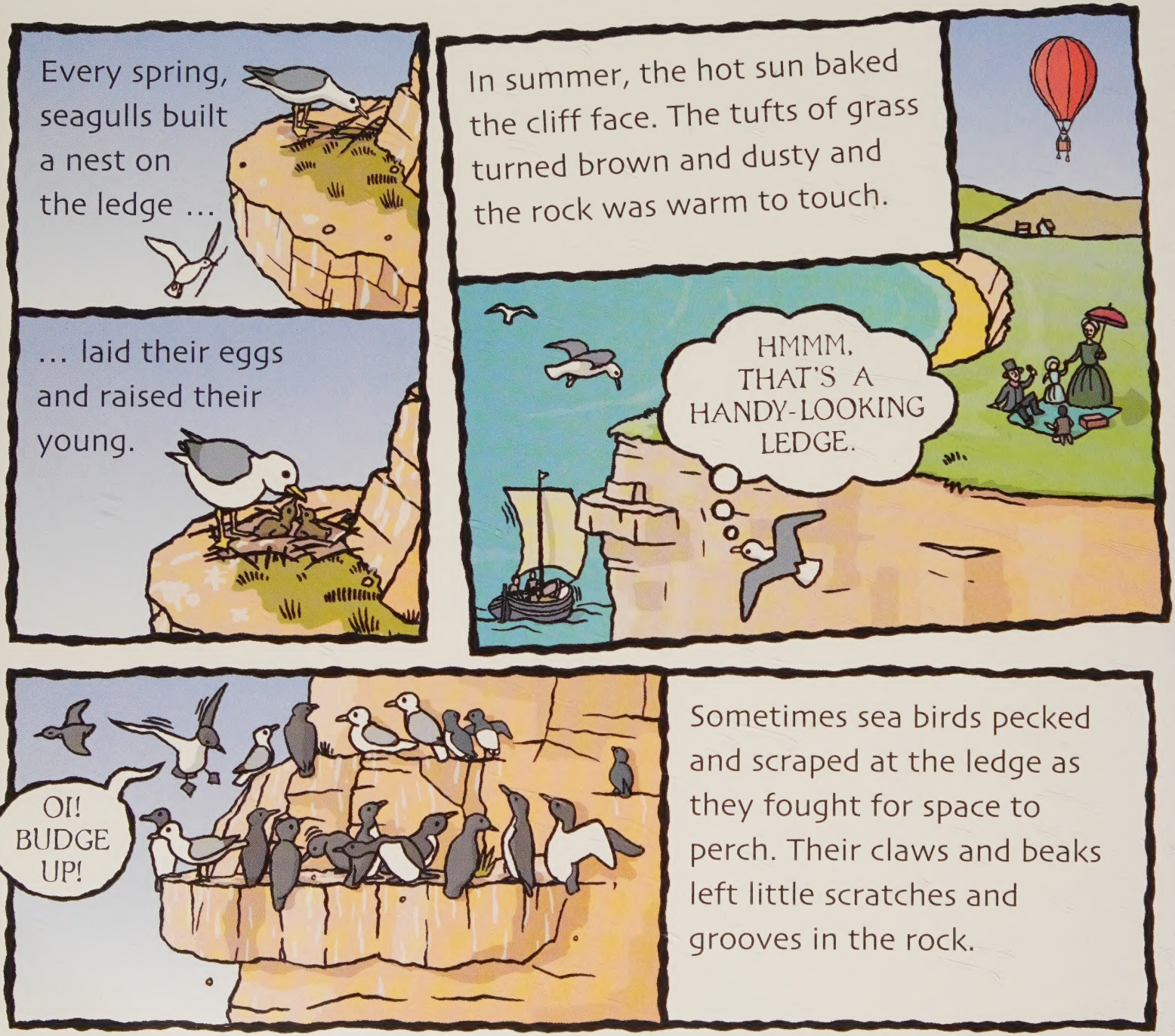
It was there when knights built castles and fought battles.



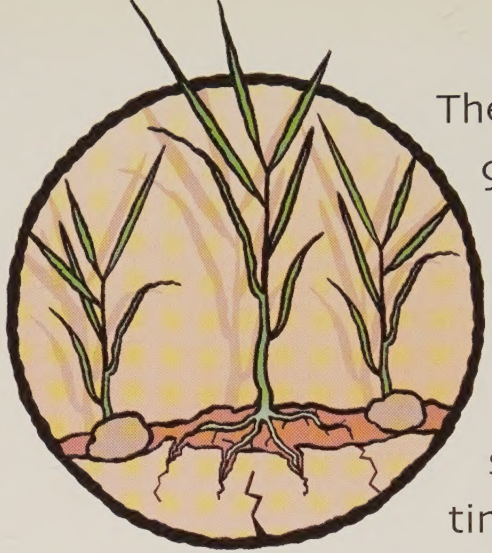
It was still there when the first steam trains puffed across the land ...



... and the first aircraft flew through the skies.


Every spring, seagulls built a nest on the ledge ...
... laid their eggs and raised their young.
In summer, the hot sun baked the cliff face. The tufts of grass turned brown and dusty and the rock was warm to touch.
HMMM, THAT'S A HANDY-LOOKING LEDGE.
OI! BUDGE UP!
Sometimes sea birds pecked and scraped at the ledge as they fought for space to perch. Their claws and beaks left little scratches and grooves in the rock.

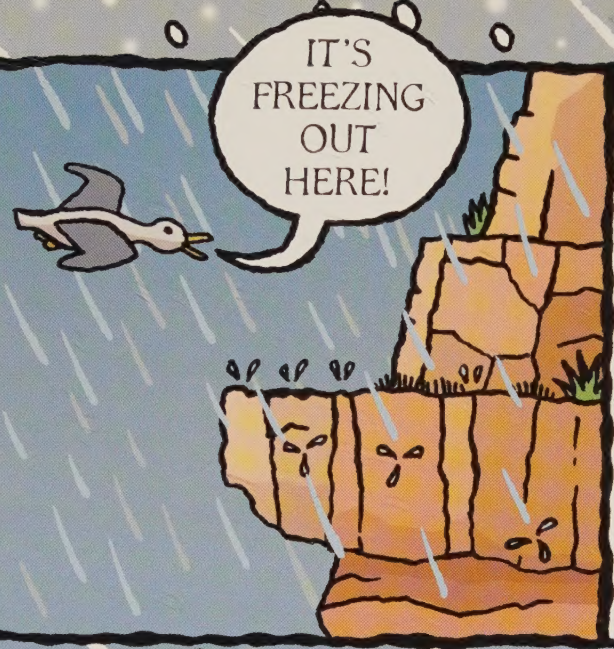
Each autumn, most of the birds flew off to warmer places. Strong winds blew in from the sea and beat against the cliff face. The wind carried specks of dust and grit that rubbed the ledge like sandpaper.



The grass that grew on the ledge pushed its roots through the thin layer of soil and into tiny cracks in the rock. The roots clung to the rock and stopped the soil from being blown away.

Soil is made from tiny powdery pieces of rock mixed with bits of dead plants and animals. Over thousands of years, rainwater crumbles rock into dust and this builds up on the land as soil. Without soil, plants could not grow.

In winter, the days were cold and wet. Rainwater soaked into every crack and hole in the cliff.



It grew so cold that the rain turned to snow and the water in the cracks froze into ice. The ice made the cracks wider. When the ice melted, the cracks filled up with more water than before.

As water freezes into ice it expands (swells up) so the ice takes up more space. The expanding ice is very strong. When water freezes inside cracks in rock, the ice is powerful enough to push the rock apart. This makes the cracks bigger, or even breaks the rock into pieces.

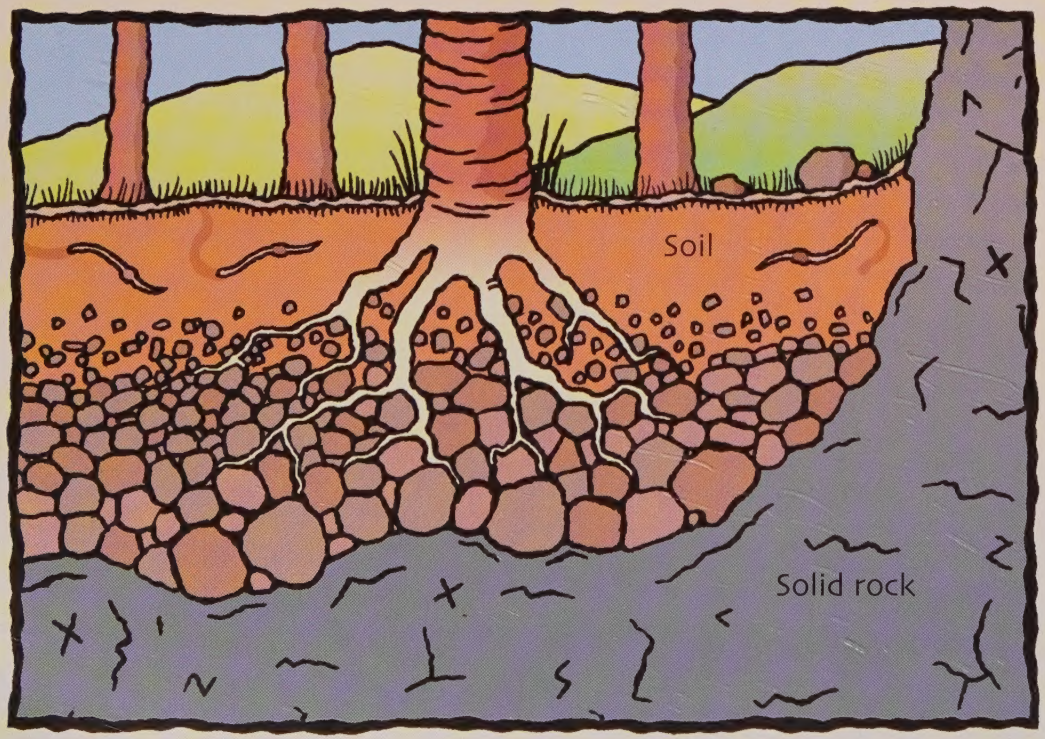
Below the ledge the seawater rose and fell. Waves crashed against the foot of the cliff, gradually undercutting it.

Each year the ledge stuck out further and further above the sea. The sun, wind and rain wore deep grooves into the sides of the ledge and its edges began to crumble.

Water is heavy. When a large wave hits something it can have as much force as a speeding car. As each wave hits the base of the cliff it thrusts water into every gap and crack. The cracks slowly widen until chunks of rock fall away. Over time, the base of the cliff is eaten away.

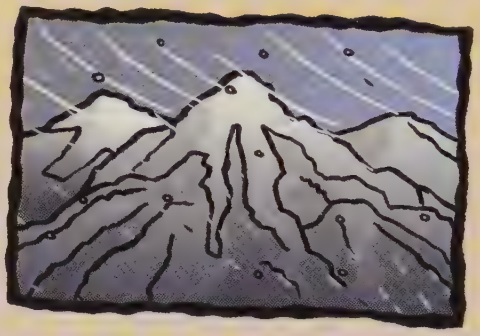
Bit by bit the ledge was being worn away. It was being eroded.

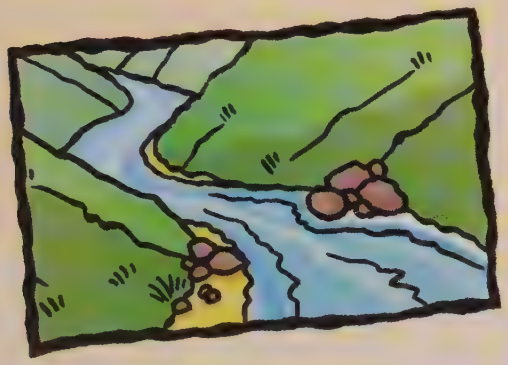
Erosion is the name scientists give to the way in which water, ice, wind and sun wear away at the Earth's surface and change the shape of the land.



The Earth's surface is made of rock. On land the rock is usually covered with a layer of soil. But you can see bare rock in cliffs and on mountainsides, where there is no soil or where the soil is very thin.

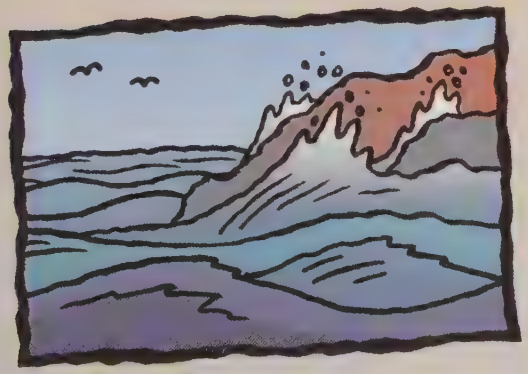
We think of rock as hard and solid, but over hundreds or thousands of years, ice and rainwater wear down mountains.





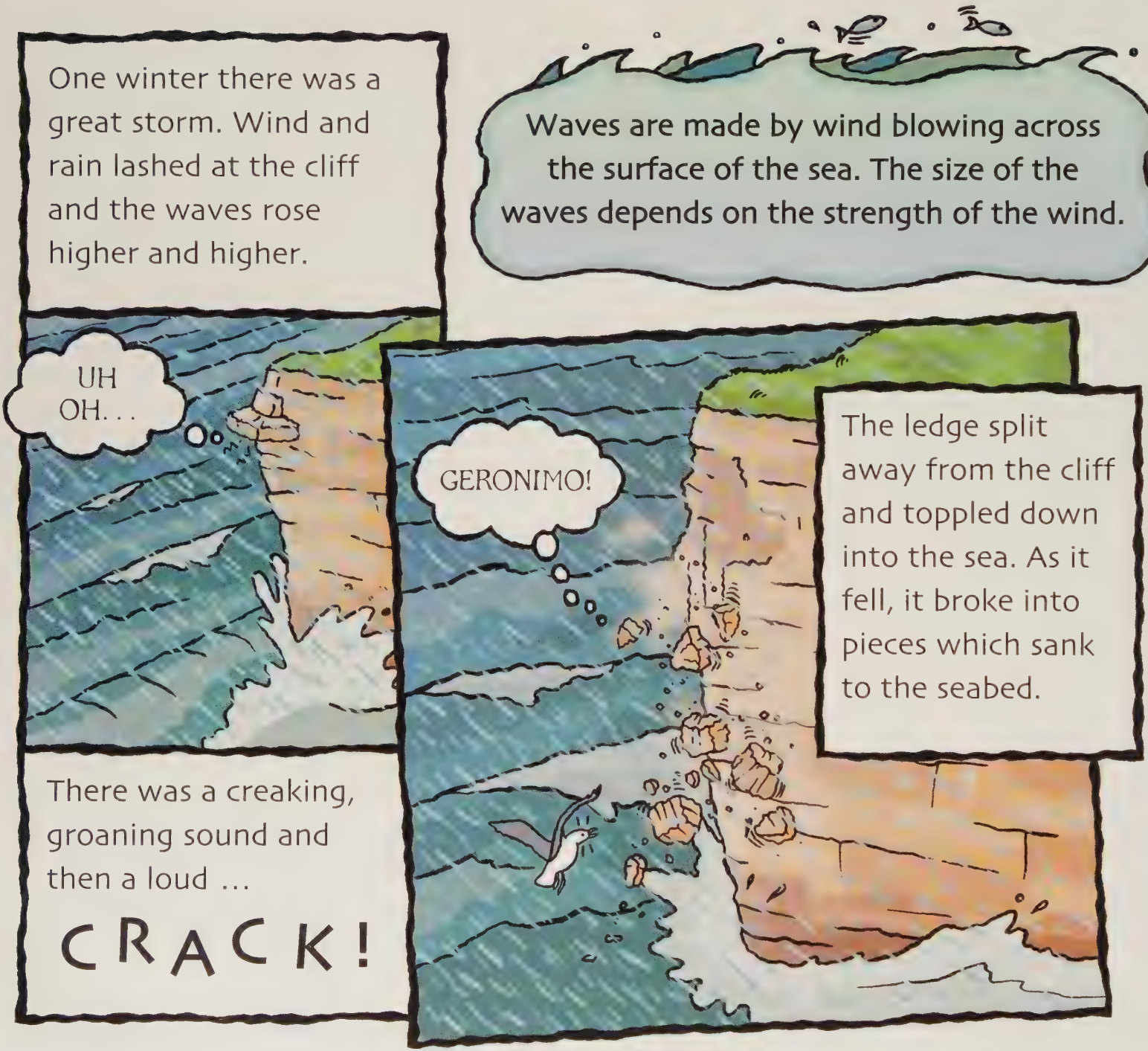
Rivers cut deep valleys into the land.

Hot days and cold nights bake and shatter desert cliffs. Dusty winds scrub against rocks and boulders, and carve them into strange shapes.



And ocean waves eat into the land's edges.

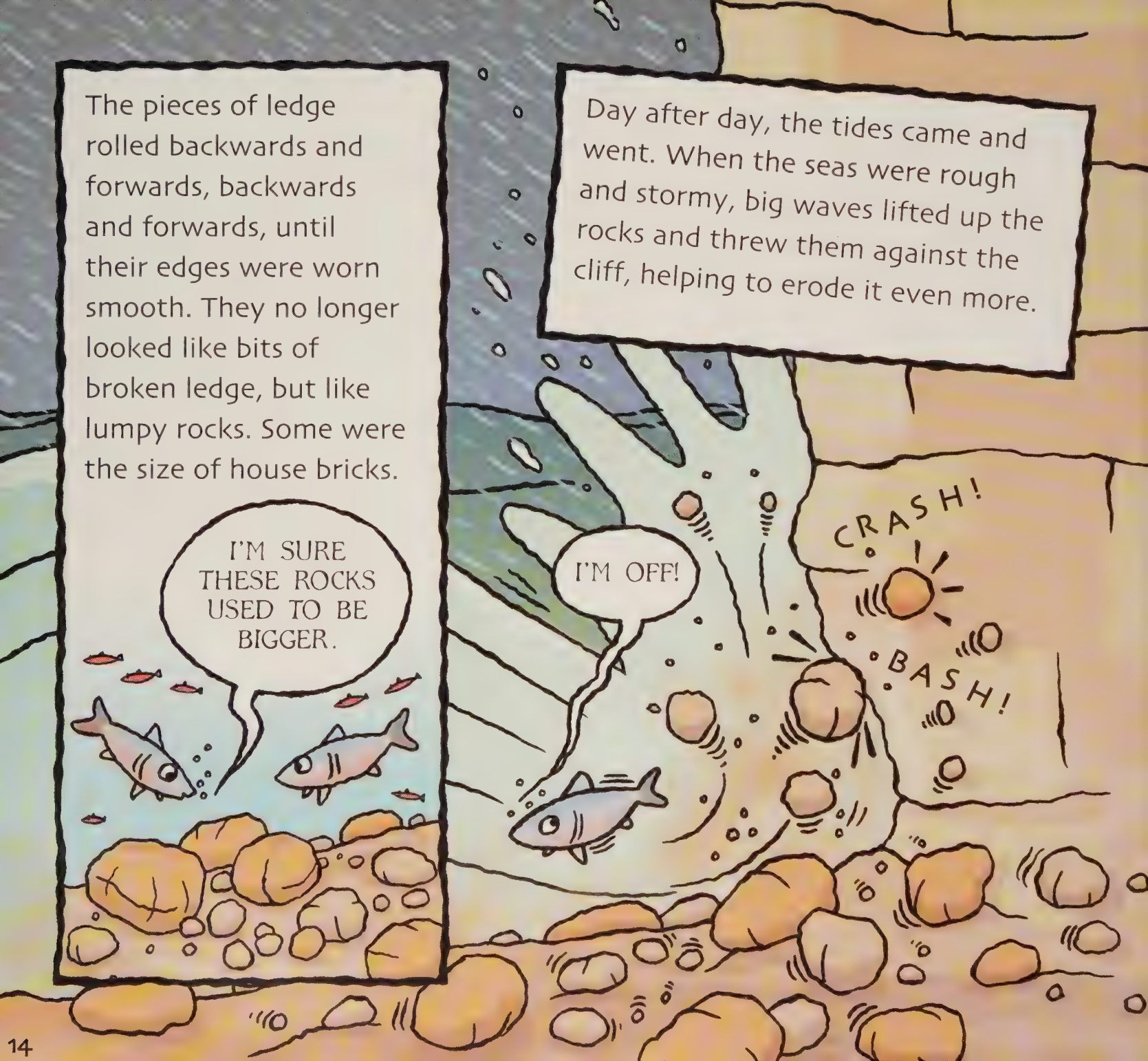
Plants help break up rocks, too. Plant roots push their way into cracks in the rock. As the roots grow, they make the cracks wider. Then water can get into the rock and make it crumble.

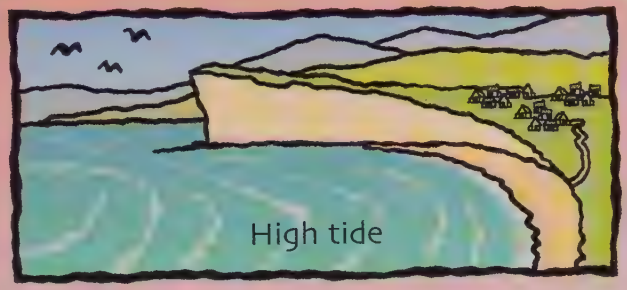

One winter there was a great storm. Wind and rain lashed at the cliff and the waves rose higher and higher.
Waves are made by wind blowing across the surface of the sea. The size of the waves depends on the strength of the wind.
UH OH. . .
GERONIMO!
The ledge split away from the cliff and toppled down into the sea. As it fell, it broke into pieces which sank to the seabed.
There was a creaking, groaning sound and then a loud ...
CRACK!

But the waves didn't let the pieces of ledge stay there. The water heaved and rolled and crashed the pieces about on the seabed, and broke them up even more.

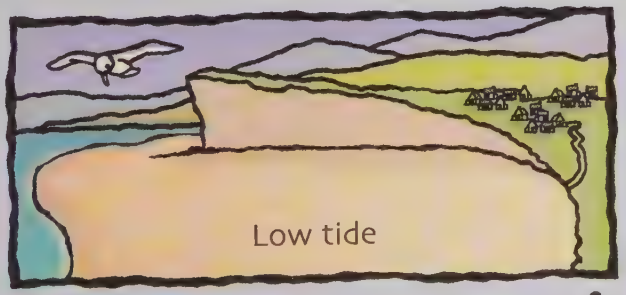
Waves don't only happen on the surface of the water. Underneath the waves, the water is churning around and around, a bit like the water in a washing machine.

The storm died away and the sea grew calmer, but still the waves rolled in. Each wave brought a surge of water that tumbled the pieces of rock forward ... then sucked them back as the water flowed away again.

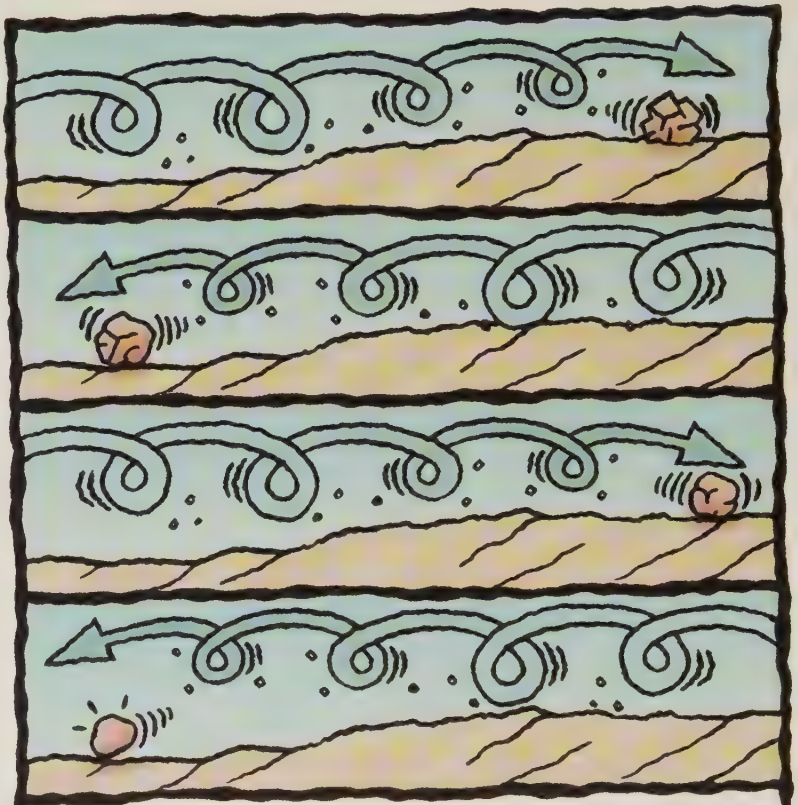

The pieces of ledge rolled backwards and forwards, backwards and forwards, until their edges were worn smooth. They no longer looked like bits of broken ledge, but like lumpy rocks. Some were the size of house bricks.
I'M SURE THESE ROCKS USED TO BE BIGGER.
Day after day, the tides came and went. When the seas were rough and stormy, big waves lifted up the rocks and threw them against the cliff, helping to erode it even more.
I'M OFF!
CRASH!
BASH!



Twice a day the sea rises higher up the coast than at other times. This rise and fall in the level of the sea is called the tide. When the tide reaches its highest point it starts to shrink back. When it reaches its lowest point, it starts to rise again.



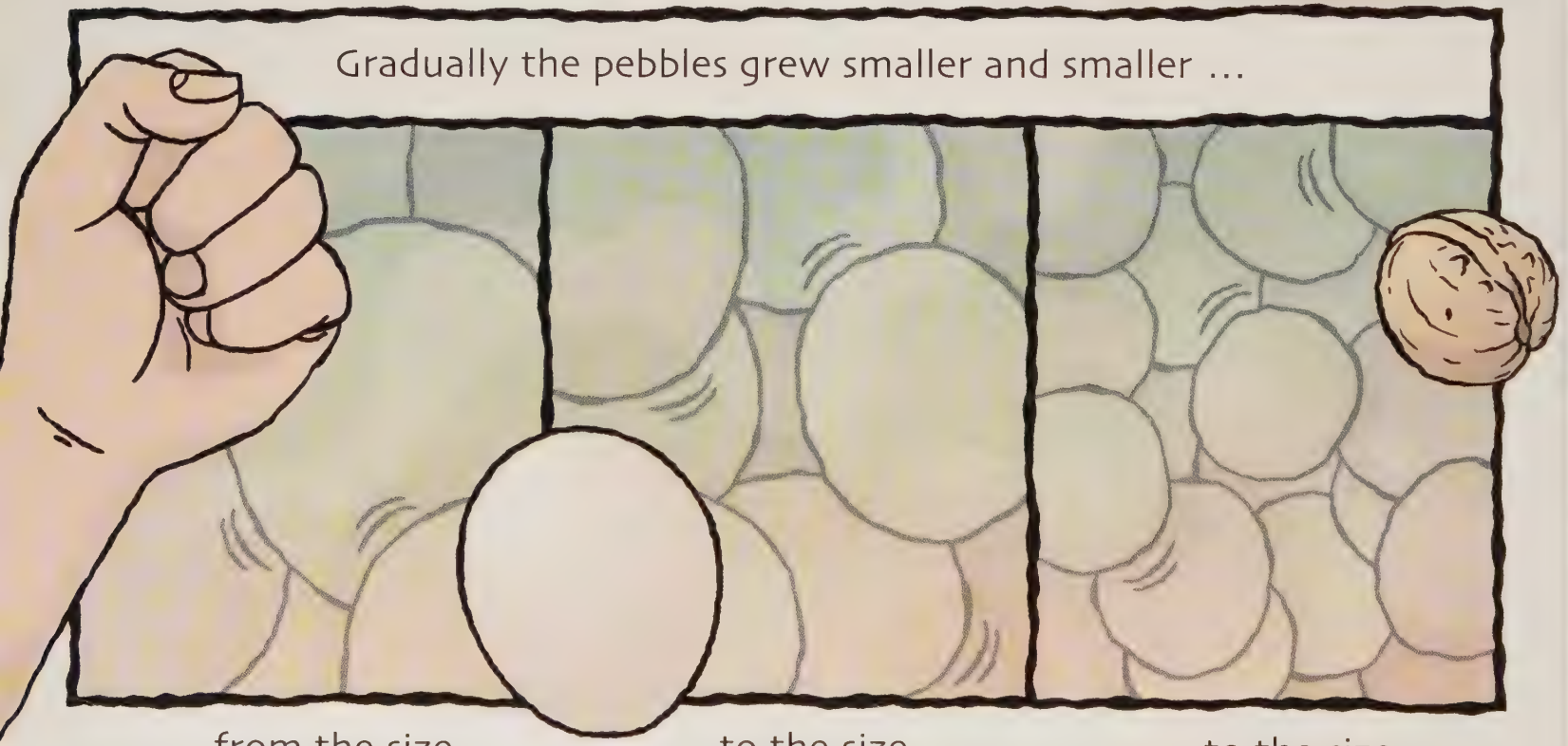
Sometimes the rocks were smashed into smaller, pebble-sized pieces.



Then their sharp broken edges were slowly ground smooth again as they rolled backwards and forwards, backwards and forwards in the sea.

All this rolling about wore the pebbles away, but something else was happening to them, too. Little by little, the water was dissolving them.

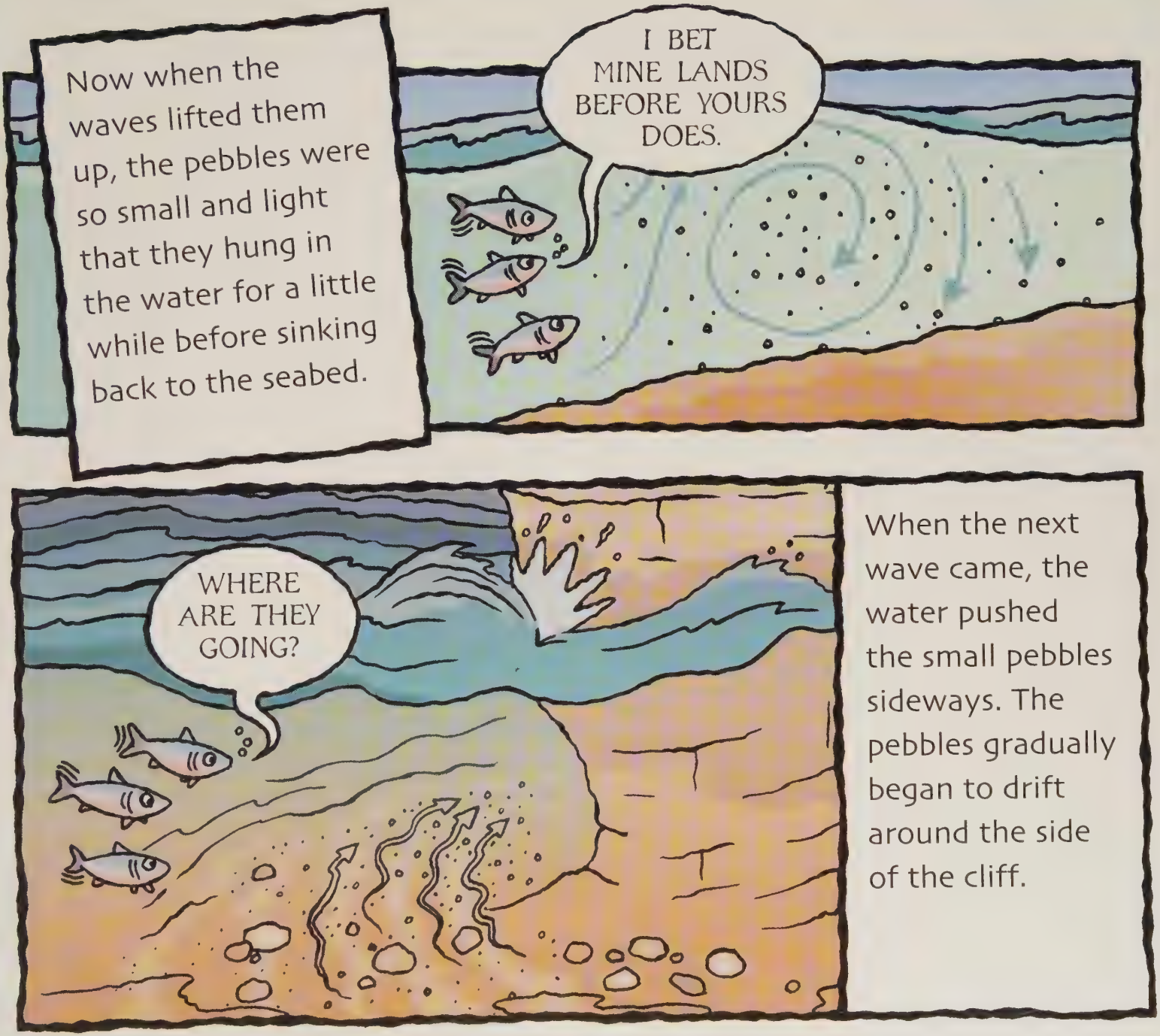
Rock is made of lots of bits of stuff called minerals. Some minerals dissolve in water and are washed away, leaving tiny holes in the surface of the rock. The holes also make the surface of the rock weaker so that it is more easily worn away.



... from the size of your fist ...

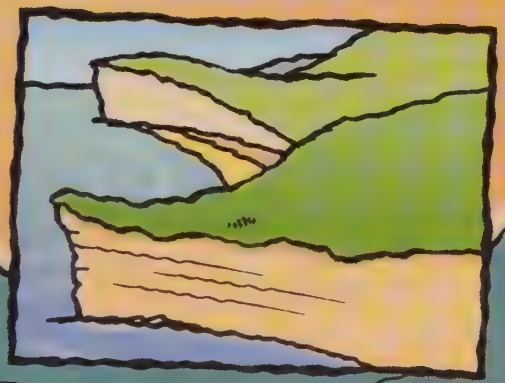
... to the size of an egg ...

... to the size of a walnut.


Now when the waves lifted them up, the pebbles were so small and light that they hung in the water for a little while before sinking back to the seabed.
I BET MINE LANDS BEFORE YOURS DOES.
WHERE ARE THEY GOING?
When the next wave came, the water pushed the small pebbles sideways. The pebbles gradually began to drift around the side of the cliff.

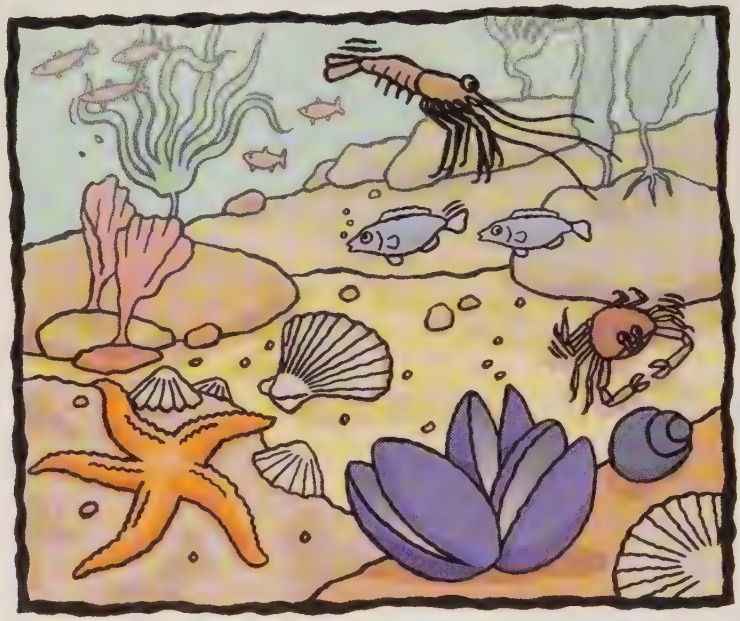
The side of the cliff curved back from the sea into a wide bay with a sandy beach. Slowly, the pebbles were being carried towards the bay.

Some types of rock are softer than others and are eroded more quickly. When soft rock lies between hard rock, the sea carves away the soft rock much faster and a bay is formed. The hard rock is left sticking out on either side of the bay.



The water in the bay was calmer than at the foot of the cliff. Here, the waves rolled all the way onto the shore.

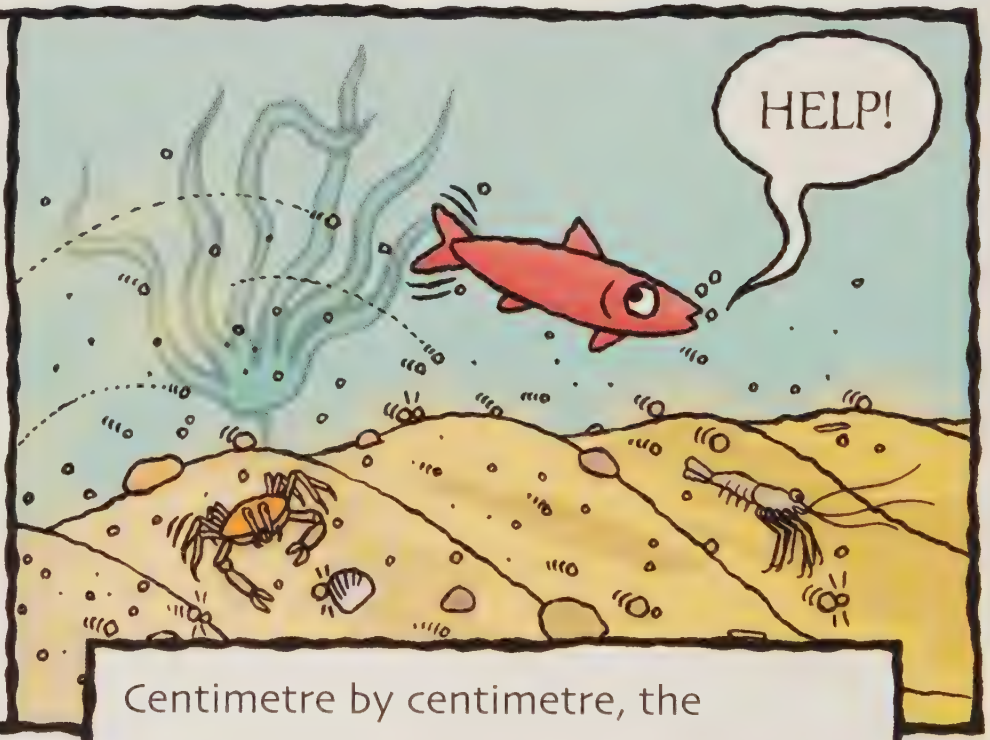
The seabed was different, too. Instead of big boulders and piles of rock, it was covered with sand and pebbles and the empty shells of dead sea creatures — with just a few large rocks dotted about.



Seaweed and shellfish clung to the rocks, and crabs, lobsters and fish darted through the water or searched among the pebbles for scraps of food.

As each wave rolled towards the shore, it picked up small pebbles and grains of sand and washed them closer and closer to the beach.

The pebbles from our ledge were carried along with the rest. As they travelled, they rubbed and rolled against the sand, stones and shells on the seabed until the pebbles were no bigger than the size of your little fingernails.

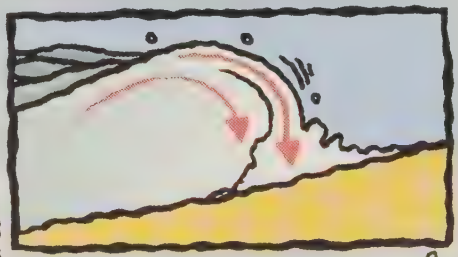


Centimetre by centimetre, the pebbles moved nearer to the shore.

One windy day, when the waves were big and fierce, the pebbles were lifted high and flung up onto the beach.

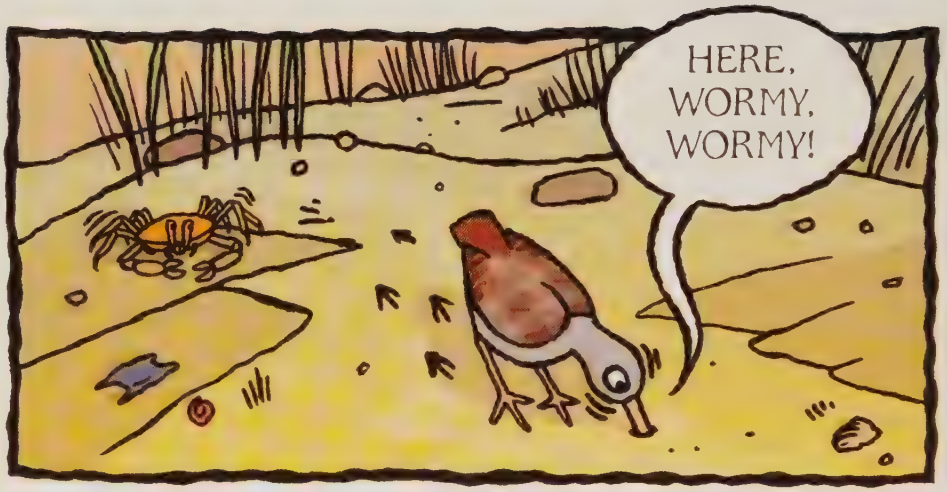
This time, when the tide went out it left the pebbles behind, gleaming in the sun. By now, the pebbles were so small they were the size of grains of rice. They had become grains of sand.

Where the seabed slopes up towards the shore, the water gets shallower. In shallow water the tops of the waves curve over and crash down in a mass of white foam called surf.



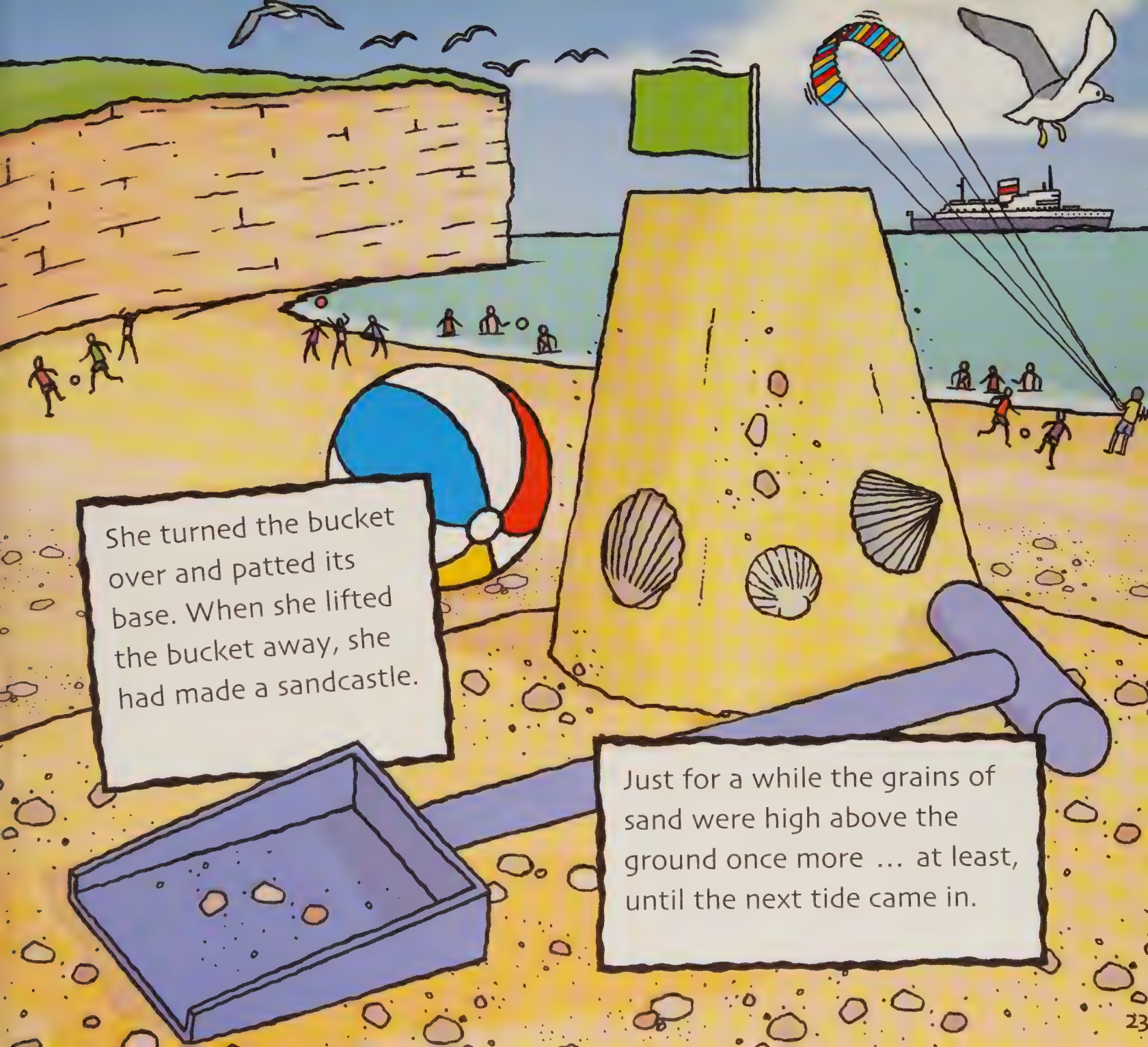
Sometimes the wind or the tides moved the grains of sand along the beach.

Sometimes shore crabs scuttled over them, or shore birds pecked at them in search of sandworms.



In summer, lots of people visited the beach and walked or played on the sand.

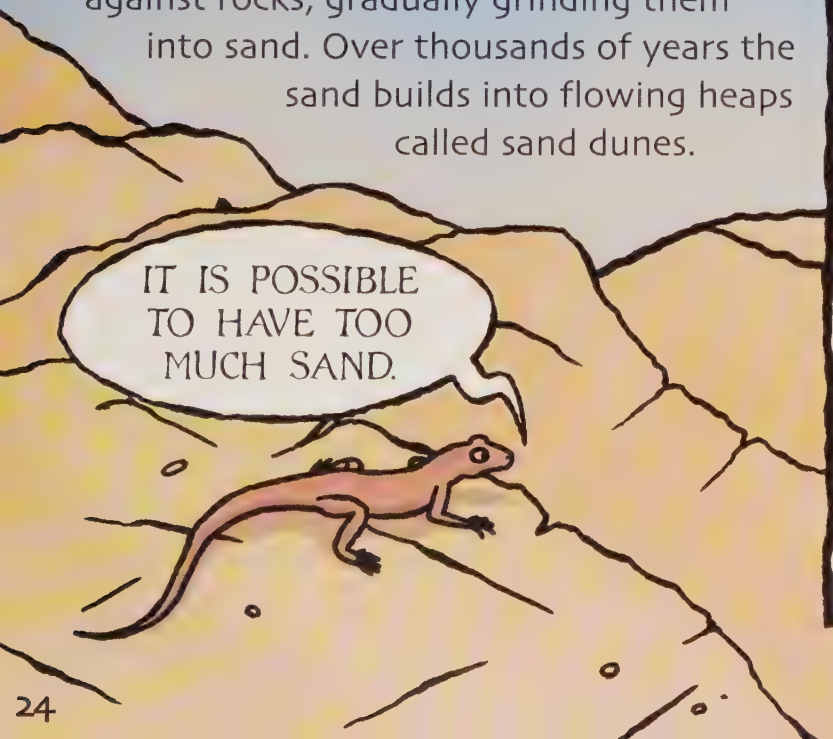
One day, a child scooped up the sand and pushed it into a bucket. She pressed it down firmly with her spade.


She turned the bucket over and patted its base. When she lifted the bucket away, she had made a sandcastle.
Just for a while the grains of sand were high above the ground once more ... at least, until the next tide came in.

Seas of Sand

Beaches aren't the only places with lots of sand. Deserts may be far from the coast, yet some contain vast seas of sand. The sand is made by the sun and wind.

Deserts have almost no rain, so there are few plants and little soil to cover the rocks. Sandy deserts are baking hot in the daytime but cold at night. The change from hot to cold to hot again cracks surface rocks apart. Dusty winds rub against rocks, gradually grinding them into sand. Over thousands of years the sand builds into flowing heaps called sand dunes.



Saving Soil

Without erosion we wouldn't have any soil. Erosion breaks down rock into dust and clay, which mix with bits of rotting plants and animals to make soil. But erosion can destroy soil, too. Soil takes thousands of years to make, but it can be blown away by wind or washed away by water in just a few months.

Plant roots, especially tree roots, help to hold down soil and protect it. In some places, people have cut down lots of trees to make way for farmland. But when the soil is left bare, rain and wind erode it away, leaving the land useless.

New for Old

With all this erosion going on, you might think there would be no solid rocks left on Earth. But erosion is often a very slow process. Some rock can take millions of years to erode, and while it is wearing away, new rock is being made.

New rock comes from deep inside the Earth. It bursts out as hot, liquid rock from volcanoes and from huge cracks in the seabed. When the liquid rock cools, it hardens into layers of solid rock. Most new rock is found on the seabed.

Rock Sandwiches

Not all rock is new rock. A lot of the rock we see on land is recycled. Sand and dust build up in thick layers at the bottom of seas and lakes. These layers get heavier and heavier as the ones on top press on those at the bottom. Eventually, the bottom layers are squeezed so hard they turn back into solid rock.

Millions of years later, as the surface of the Earth slowly changes, these layers of rock may be pushed back up to the surface again as cliffs or mountains.

TRY IT AND SEE

EXPANDING ICE

When water freezes it has the power to push rocks apart.

Try this experiment to discover the strength of expanding ice.

You will need:

- A plastic tumbler
- Some water
- A saucer that fits on top of the tumbler
- A large pebble or other weight

1 Fill the tumbler with as much water as you can and place the saucer on top.

2 Put the weight on top of the saucer and carefully put the whole thing in the freezer overnight.

3 When you take it out of the freezer you should see that the ice has lifted the saucer and the weight above the rim of the tumbler.

Ice Attack

Cold nights and warmer days can freeze and thaw rocks over and over again.

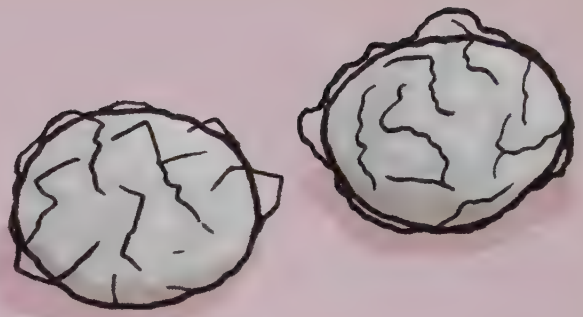
See how these changes of temperature help to erode rocks.

You will need:

- Modelling clay
- A water spray (e.g. a plant mister)
- Clingfilm
- A saucer

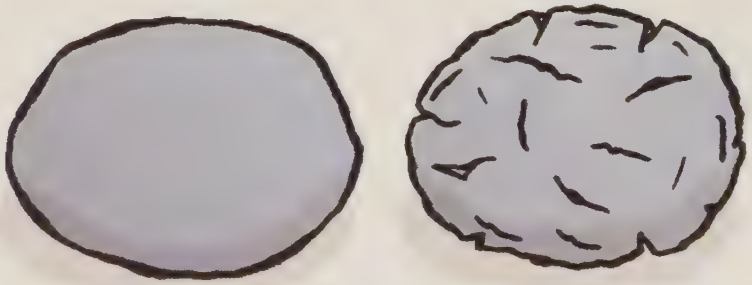
1 Divide the clay in two and roll each piece into a ball.

2 Spray both the clay balls with water and wrap them up in clingfilm.



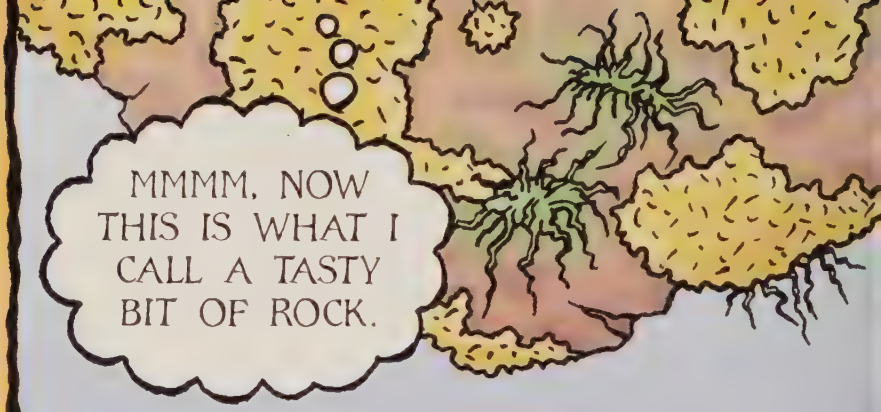
3 Leave one on a saucer and put the other one in the freezer overnight.

4 In the morning, take out the frozen ball and let it thaw out. Then unwrap the clingfilm and compare the two balls of clay. The one you froze should have some small cracks on its surface. If you keep spraying, freezing and thawing it, the cracks in the clay will get bigger and bigger. This is what happens to rocks.



CRACKING FACTS

When sand is heated to more than 1200°C it melts into a clear liquid. When the liquid cools it hardens into glass. Glass-blowers make beautiful shapes with glass by dipping a long tube into the hot liquid and blowing down the tube into the blob of glass at the end.



You often see patches of crusty-looking green or yellow plant-like stuff growing on rocks. These are lichens (*lie-kens*). Lichens don't need soil to grow — they can live on bare rock. They make a liquid that slowly seeps into the rock and dissolves it so the lichens can suck up minerals from the rock. This weakens the rock and it erodes more quickly.

Erosion doesn't only happen on the Earth's surface. Rainwater soaks through soil into the rocks below. Some rocks, such as limestone, dissolve in water — just like sugar dissolves in tea, only much more slowly. The water gradually wears away at the rock. Over thousands of years, cracks become holes, caves and huge caverns, hidden deep underground.

INDEX

bays 18, 19
beach animals 22
beaches 18, 20, 21, 22
caves 28
deserts 11, 24
erosion 9, 10–11, 14, 19, 24, 25, 28
ice 8, 10, 11, 26, 27
lichens 28
minerals 16, 28
mountains 10, 11, 25
pebbles 15, 16, 17, 18, 19, 20, 21
plants 7, 11, 24
rainwater 8, 9, 11, 12, 24, 28
rivers 11
rocks 6, 7, 8, 9, 10, 11, 13, 14, 15, 19, 24, 25
  dissolving rock 16, 28
roots 7, 11, 24
sand 19, 20, 21, 22, 23, 24, 25, 28
seabed 12, 13, 17, 19, 21, 25
sea creatures 19
seagulls 6
seaweed 19
shells 19, 20
snow 8
soil 7, 10, 24
sun 6, 9, 10, 24
surf 21
tides 14, 15, 21, 22, 23
undercutting 9
valleys 11
volcanoes 25
water 9, 10, 11, 13, 16, 24
waves 9, 11, 12, 13, 14, 17, 19, 20, 21
wind 7, 9, 10, 11, 12, 21, 22, 24

SOME EROSION WEBSITES TO VISIT

http://www.bbc.co.uk/schools/riversandcoasts/index.shtml = lots of good information about coasts and how they change, with animated diagrams.

http://interactive2.usgs.gov/learningweb/explorer/topic_rocks.htm = the educational bit of the United States' Geological Survey website, with tons of facts and links to other good sites.

http://www.rocksforkids.com = run by two Canadian teachers, and tells you everything you might ever want to know about rocks and minerals.

For Chris
JB

For Ben
ML

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